Summary of the Method Used to Develop an Algorithm to Predict the % Imperviousness of Watersheds

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The first step in developing an algorithm to predict imperviousness was to isolate each urban land use coverage from the MaineCombo land coverage on ArcView. MaineCombo separated urban land coverages into seven different classifications: high intensity residential, low intensity residential, commercial-industrial-transport, urban industrial, dense residential, sparse residential, and highways/runways. The goal was to determine the average % imperviousness of each different urban land use.

In order to accomplish this goal, we started with the high intensity residential land coverage and drew ten separate polygons in towns and cities all over the state that enclosed an area of only high intensity residential pixels. After drawing each polygon, the MaineCombo land coverage was overlain with the orthoquads for the city or town the polygon was drawn in. As one might expect, the impervious surfaces in these polygons were associated with rather uniform residential development. In order to estimate the % imperviousness of each polygon, we first estimated the density of houses per acre within the polygon and applied it to a formula derived from Chandler Morse's (a recent UMO graduate student studying the effects of development on streams) impervious estimation work: **% imp = (((28.8-13.4)(X-1))/(4-1))+ 13.4,** where X is the house/acre value that I found in the polygon. This formula works assuming that the house/acre value is more than 1 but less than 4. Any value over 4 or less than 1 requires a different formula. The output from this formula was the total % impervious area for the polygon. After applying this formula to all ten polygons, the % impervious values were averaged to arrive at the average % imperviousness for the high intensity residential land use class. The same procedure was followed for the other three residential land use classes.

The non-residential land coverages, such as commercial-industrial-transport (CIT), required a slightly different method to determine the % imperviousness. For the CIT land use ten polygons were drawn in the same manner as for the residential land uses. Since not all the land was residential, sub-polygons were drawn around areas that were 100% impervious (i.e. buildings, parking lots, roads). We counted the number of houses that were within the large polygon and estimated that each house had approximately .05 acres of impervious area (based on Chandler Morse's estimations). The number of houses by was multiplied by .05 acres and added to the total area that was 100% impervious, then divided by the area of the polygon to arrive at the total % impervious area for the CIT polygon. Again, the estimated % imperviousness of all ten polygons were averaged to determine the average % imperviousness of CIT. The urban industrial land use was easier to determine because there were virtually no residential areas within this coverage. We were not able to come up with an average % imperviousness of highways/runways because there was not enough land coverage in which to draw polygons.

The average % imperviousness of all six urban land coverages were used to derive an algorithm that would predict the % imperviousness of entire watersheds. The average % imperviousness of each land coverage is as follows:

High Intensity Residential	**27.11%**
Low Intensity Residential	**17.26%**
CIT	**54.04%**
Urban Industrial	**90.20%**
Dense Residential	**56.50%**
Sparse Residential	**11.98%**

Thus, the draft algorithm to predict the % imperviousness of watersheds was the following:

Watershed % imp = ((Area of High Intensity Residential*27.11)+(Area of Low Intensity Residential*17.26)+(Area of CIT*54.04)+(Area of Urban Industrial*90.20)+(Area of Dense Residential*56.50)+(Area of Sparse Residential*11.98))/ Total Land Area

In order to calibrate this algorithm to real watershed data, we used estimates of % imperviousness for 20 watersheds that Chandler Morse had developed detailed imperviousness estimates for. After applying the algorithm on the twenty known watersheds, it was discovered that the algorithm was slightly overestimating the % imperviousness of most of the watersheds. Plotting the points on a scatterplot revealed that a multiplier of .85 would bring the points closer to Chandler Morse's estimated imperviousness. Thus, the refined algorithm was the same as above, except that the final output value was multiplied by .85:

Watershed % imp = .85((Area of High Intensity Residential*27.11)+(Area of Low Intensity Residential*17.26)+(Area of CIT*54.04)+(Area of Urban Industrial*90.20)+(Area of Dense Residential*56.50)+(Area of Sparse Residential*11.98))/ Total Land Area

In order to test whether the refined algorithm was appropriate, a test set of polygons was created. We drew 25 random rectangle polygons around the state that included many different land coverages. These were then overlaid with the orthoquad for each polygon and the impervious areas delineated within the polygon. The same formula was used to determine the impervious areas of residential sections and these were added to all areas that were 100% impervious and divided by the total polygon area. This resulted in an orthoquad based estimate of total % impervious for the polygon. Using the 'tabulate areas' function in ArcView, we determined the density of each land coverage within the specific polygon. These values were applied to the refined algorithm, to derive a Maine Combo based estimate of each polygons % imperviousness. When these estimates were compared to the ortoquad based estimates, it was found that the .85 multiplier helped to bring the points closer to 100% accuracy and that the adjusted algorithm would do a good job at predicting the % imperviousness of most watersheds.